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THE REALIZATION OF THIN SHEETS STAMPING TOOLS WITH AN ECONOMICAL MATERIAL

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ABSTRACT

Given the complexity of manufacturing (machinability) and the analysis of the design parameters of the stamping tools that influence the time, cost and quality of production, we attempted to focus search on an economic material that substitutes the tools such as steel or cast iron stamping tools such as HPC and UHPC concrete tools. Several formulations of these concretes have been tested.state which is comparable to the surface condition of the metal tools.

Tests on a quasi-industrial line have given encouraging results and confirm that UHPC concrete tools have an important tendency for the production of small series (≤ 500 pieces)

KEYWORDS: Stamping, High Performance Concrete, Wear, Surface Finish & Hardness.

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Original Article

INTRODUCTION

Thin wall structures are used in various industrial applications. The shaping processes of these structures depend on the material used and the geometry of the desired product. In the case of metallic materials where the forces required for shaping are important, the thin-walled products are manufactured by stamping from sheet metal sheets. This process is widely used in the automotive industry for the production of body parts. The development of manufacturing processes is generally based on long and costly series of tests. As a result, manufacturers have always sought to find technological solutions that reduce the cost of shaping steel sheets, which may be important. Among these solutions, the substitution of steel or cast iron stamping tools by high-performance concrete stamping tools (HPC, UHPC) is the main objective of this study, although the research has resulted in technical solutions that have provided encouraging results such as hydraulic concrete prototype tools covered at least partially with a metallic layer [1], [7] drawing tools made by a stack of metallic strata, assembled by various techniques [8] and the design of prototype reactive powder concrete (RPC) tools [2].

High-performance concrete tools (RC ≥120MPa) have been designed and manufactured with high characteristics in terms of hardness, permeability and a perfect surface finish of the working surface without any air bubbles. The design and manufacture have been validated by industrial testing. The first tests on a quasi-industrial hydraulic press at the level of a private company gave encouraging results.

MATERIALS AND METHODS

Materials

The materials used for the realization of the concrete stamping tool are used for the design of the

ergoccidental in the formulation of the UHPC, except that the crushed quartz has been replaced with the crushed sand [6] as presented in Table 1

Figure.1: Photos of Each Constituent

Cement

The cement chosen in this study is of Portland type composed of CPJ CEM II / B 42.5. It complies with the Algerian standard NA 442.

Addition

- Silica fume marketed in powder, gray in color.
- Crushedsandof Taghit (less than 80 μm). [9]

Adjuvant

Superplasticizer used is SIKAPLAST 5045 / High Water Reducer. Complies with the NF EN 934-2 standard.Metallic fibers made of steel and synthetic fibers have been used Water Physical properties and chemical analysis of cement and sandcrushed are presented in Tables 1, 2 and 3. [11]

Table 1.Physical Properties of Cement and Crushed Sand Dune

	Apparent density	Specificdensity	Fineness
CEM II/B42.5	1030	3060	3242
Crushed Sand Dune	1150	2650	3000

Table 2.Mineralogical Composition of Cement (%)

Cement Type	C_3S	C_2S	C_3A	C_4AF
CEM II/B42.5	55.41	13.65	2.25	14.83

Table 3: Chemical Analysis of Cement and Crushed Sand Dune of Taghit.

Eléments	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Autres	P.F.
Crushedsand Dune	97.15	0.79	0.21	0.11	0.05	0.14	0.18	0.02	<0.02	0.58
Cement	17.49	4.51	3.02	62.78	2.5	2.3	0.05	0.64	0.02	8.10

Granulometric Analysis of Aggregates

The granulometric analysis of the aggregates is presented in the following figure 2

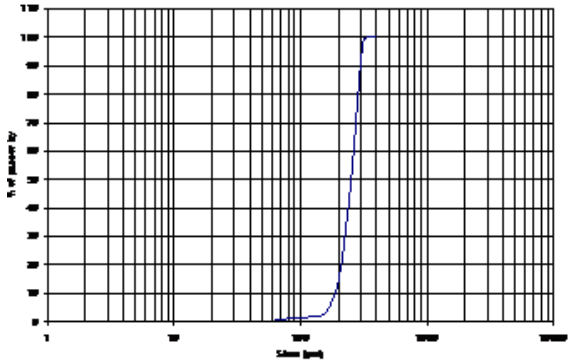

Figure 2: Granulometry by Sieve Analysis of Sand of Dune

METHODS

Formulation

Most of the UHPC formulas are currently being designed experimentally.

The development of these UHPC formulas consists in determining the quantities of each constituent in order to meet the specifications of these new concretes: [10]

- A very low E / C ratio (<0.2);
- An increase in compactness by optimization of the granular skeleton;
- The use of fine sand (0.063 mm <dmax<2 mm) in order to improve homogeneity;
- The use of ultra fine;
- The use of ground sand in the case of heat treatment above 90 ° C;
- A superplasticizer assay close to its saturation assay;
- The use of metallic fibers to increase ductility.

Table 4: Proportions of Concrete Mixture (kg/m^3) with Silica Fumeand Sand Dune [6]

UHPC	
Materials	**Proportion [kg/m^3]**
Cement	691
Sand Dune	759
Silica Fume	172
Crushed Sand	276
Superplasticizer	37
Water	200
Metallic Fibers	138
Densitytheoretical (kg/m^3)	2399
E/C	0.27

Shaping Process

Stamping is a process for shaping metallic thin-film materials. This involves giving a spatial dimension to an initially planar metal foil. It may be in the form of a strip or a blank. This method makes it possible to obtain pieces of complex shapes, which are generally non-developable, which is to be opposed to other methods such as folding or rolling. The stamping makes it possible to manufacture, among other things, parts for automobile manufacture, for household appliances, kitchen utensils. [4], [5]

Stamping is carried out using high-power pressing machines equipped with special tools, which in principle have three parts: Figure. 3.

- A hollow matrix in conformity with the external shape of the part;
- A punch, in relief, conforms to its internal shape by reserving the thickness of the sheet;
- A blank holder is used to wedge the sheet during the application of the punch.

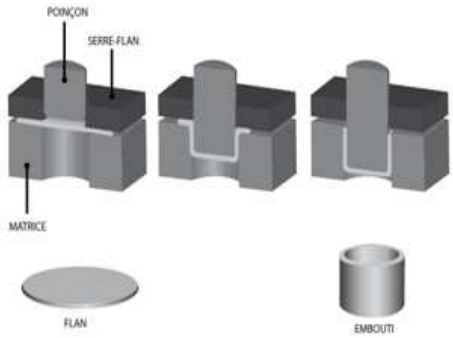

Figure 3: Stamping Principle

Design of a Concrete Stamping Tool

A drawing tool was designed and realized from an existing steel tool in Figure. 4, firstly a silicone mold was produced which gave a better impression of the tool figure 5 and then we cast our concrete in the carefully cleaned silicone mold, without lubricant or release agent. After 24 hours under ambient conditions, our tool was un-molded without any difficulty. The tool is put in water for three days, and after drying in ambient air for half a day, it is heat-treated in an oven at 150 ° C for three days.

Figure.4: Steel Tool

Figure 5: Silicone Mold

Figure 6: Concrete Tool UHPC

RESULTS AND DISCUSSIONS

Mechanical Characterization of Hardened Concrete

The tests are carried out on laboratory specimens 40x40x160 mm fibered and unbundled. These specimens underwent heat treatment, the first results of which show that the performance of the concrete has been improved.

Table.5: Compressive Strength [MPA]

Time(Days)	HPC	HPCF
1	25.36	20.56
7	54.54	59.37
14	60.39	78.44
28	85.13	109.74

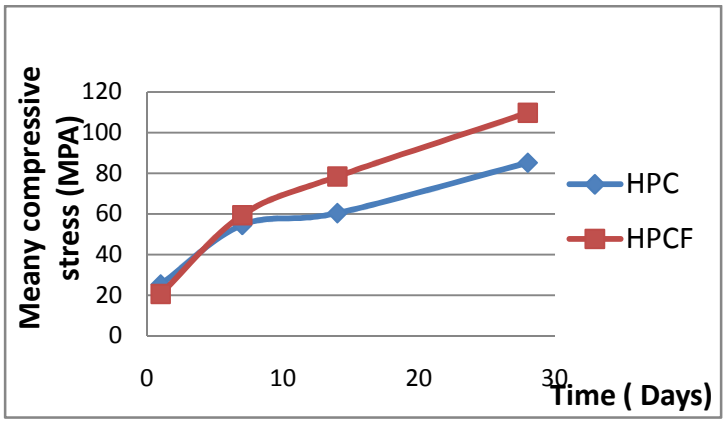

Figure 7: Representation of the Variation of the Mean compressive Stress of Concrete UHPC According to Timing

Roughness

It is recommended to characterize their mechanical properties, i.e. compressive strength, flexural strength, hardness, shrinkage, but also their surface characteristic, i.e. the surface finish of the working part, using a roughness meter.

The roughness (figure. 9) of the concrete tool see figure. 6 is compared with that of the steel tool (Figure. 8).

Figure 8: Roughness of the Steel Tool (Ra = 0.16 µm)

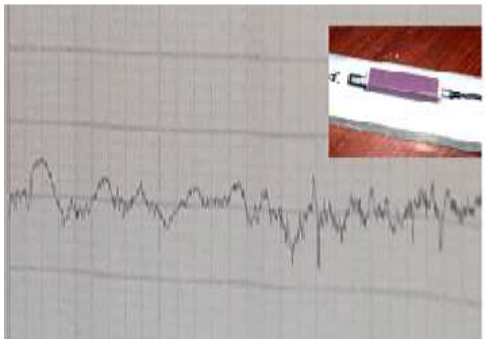

Figure. 9. Roughness of the Working Face of the Concrete Tool (Ra = 0.39 µm)

Tool Testing in UHPC

The surface state of the working external part of the tool must be minimal in order to limit the penetration of aggressive agents, bibliographic research shows that the coefficient of friction between concrete and sheet is of the same order as that of steel / sheet metal or cast iron / sheet metal. [2]

The concrete tool is tested on a hydraulic pressing press of 400 tons in a private company in Figure. 10. For the production of bodywork of an air conditioner, the results obtained are acceptable in comparison with those obtained with a steel tool.

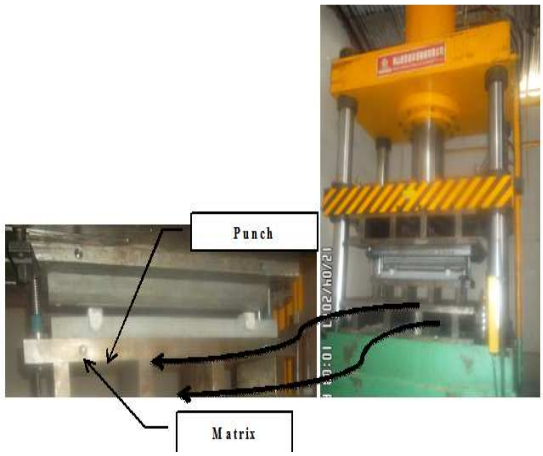

Figure.10: Hydraulic Press 400 Tons

Figure.11: Work Part

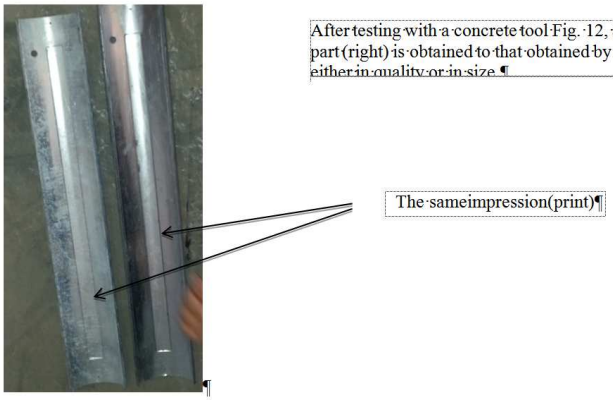

Figure.12: Parts Obtained

CONCLUSIONS

This study has shown that the design and construction of UHPC concrete stamping tools have fairly encouraging mechanical properties and have a perfect external quality, no air bubbles, after heat treatment, the concrete tools have a hardness and behavior to high wear. This study shows that these concrete tools have simplified the process, decreased the manufacturing time because these solutions involve the elimination of the machining of metallic materials and consequently a very significant economical efficiency.

For instance, a steel tool weighing 26734 g, the same concrete tool weighs 7264 g. about 36% of the mass.

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